2020

Is Aquatic Therapy Effective in Improving Motor Activity in Patients With Parkinson's Disease?

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A SELECTIVE EVIDENCE BASED MEDICINE REVIEW

In Partial Fulfillment of the Requirements For

The Degree of Master of Science

In

Health Sciences – Physician Assistant

Department of Physician Assistant Studies
Philadelphia College of Osteopathic Medicine
Philadelphia, Pennsylvania

December 13, 2019

ABSTRACT

OBJECTIVE: The objective of this selective EBM review is to determine whether or not aquatic therapy is effective in improving motor activity in patients with Parkinson's disease.

STUDY DESIGN: A systematic review of three English language primary studies, one of which published in 2011 and two in 2017.

DATA SOURCES: Three randomized control trials (RCT); two single blind and one controlled, open-pilot trial published in peer-reviewed journals analyzing if aquatic therapy is effective in improving motor activity in patients with Parkinson's disease. Articles were found on PubMed.

OUTCOMES MEASURED: The outcome measured was motor activity using the Unified Parkinson's Disease Rating Scale (UPDRS) section III.

RESULTS: All three studies found that aquatic therapy significantly improved motor activity when compared to traditional land-based therapy in Parkinson's diseased patients. Carroll et al. study showed a mean change from baseline for the aquatic therapy group in motor activity at 6 weeks and no mean change from baseline the control group. When comparing the two groups, there was a clinically significant change, p=0.01(Carroll LM, Volpe D, Morris ME, Saunders J, Clifford AM. *Arch Phys Med Rehabil*. 2017;98(4):631-638. doi: S00039993(17)30002-3 [pii]). Vivas et al. study did a follow-up ANOVA that showed participants in the water-group, from pretest to posttest, changed significantly in the UPDRS, motor aspect, compared to participants in the land-based group. Between the groups there was a statistically significant difference in the water-group, with a p-value of 0.001 (Vivas J, Arias P, Cudeiro J. *Arch Phys Med Rehabil*. 2011;92(8):1202-1210. doi: 10.1016/j.apmr.2011.03.017 [doi]). Perez de la Cruz et al. study found that the experimental group had significant differences post-treatment in improved motor activity, with a p value $P<0.001$, compared to the control group where no improvement was seen (Perez de la Cruz S. *Eur J Phys Rehabil Med*. 2017;53(6):825-832. doi: 10.23736/S1973-9087.17.04647-0 [doi]).

CONCLUSSIONS: The evidence presented in this review shows that aquatic therapy does improve motor activity in individuals with Parkinson's disease. Significant results were found in each article, however, due to limitations, including small sample sizes, further research should be done to confirm these findings.

KEY WORDS: Hydrotherapy, Parkinson's disease

INTRODUCTION

Parkinson's disease (PD) is a neurodegenerative disorder that affects different regions of the brain, most commonly the area called the substantia nigra. This area of the brain specifically controls balance and movement. Patients with Parkinson's disease lose cells in the substantia nigra and are seen to have dopamine concentrations that are markedly decreased.[1] The incidence of Parkinson's disease increases with age. It affects more than one million people in North America and over four million people worldwide.[2] There are approximately 60,000 new cases per year and 13 per 100,000 people affected in the United States.[1,2] With such a high prevalence, it is crucial to research therapies that will help slow the progression of motor symptoms in these patients.

According the American Journal of Managed Care (AJMC), as of June 2019, Parkinson's disease accounted for an estimated economic burden of $25.4 billion from medical costs, $26.5 billion from missed work, lost wages, forced early retirement and caregiver time.[3] With regards to healthcare visits, in 2015, approximately 200,000 patients with Parkinson's disease were hospitalized, 37,000 were readmitted to the hospital, 9,700,000 patients attended an outpatient visit, 34,000 were put on hospice, 113,000 lived in skilled nursing facilities and 466,000 made visits to the emergency room.[4]

Currently, the exact cause of Parkinson's disease is unknown, however, several factors play a role in the etiology of the disease. Some factors include genetics, while other factors include environmental triggers.[1] Familial cases of Parkinson's disease can be caused by a mutation in certain genes codes, but these cases are unpredictable; being that some patients with these mutations may have no known family history.[2] Cardinal symptoms of Parkinson's disease include tremors, bradykinesia, rigidity, impaired posture and balance, and loss of autonomic

movements.[1,2] Carbidopa-levodopa (Sinemet) is currently the most effective medication to treat the symptoms in Parkinson's disease.[5] Dopamine agonists, monoamine oxidase B (MAO-B) inhibitors, catechol O-methyltransferase (COMT), and anticholinergics are medications that can be used as an adjuvant therapy with carbidopa-levodopa to improve symptoms. Surgical deep brain stimulation is indicated for patients who are resistant to medications.[5] Physical therapy and occupational therapy also play a role in symptomatic management of Parkinson's disease. These therapies are important to improve motor skills and gait disturbances along with activities of daily living.[2] Currently, there is no cure for Parkinson's disease, however, the pharmalogic, surgical and non-pharmalogic treatments mentioned above are used to manage symptoms of the disease. As of now, aquatic therapy is not used routinely for the management of Parkinson's disease. Aquatic therapy can help patients with the disease move more easily while reducing the fear of falling.[6]

This paper evaluates three randomized control trials (RCTs) comparing the efficacy of aquatic therapy for improving motor activity in adult patients with Parkinson's disease compared to traditional land therapy. Physical exercise has the potential to be helpful for Parkinson patients on a motor level, including things like gait, balance, strength and posture.[5] Combining physical exercise and water therapy makes a safer environment for patients with Parkinson's disease and also makes therapy more beneficial. The water provides increased resistance for these patients as they progress through their therapy.[6] Along with that, water therapy allows the therapist to control the temperature and having warmer temperatures provide an additional therapeutic effect that can help improve rigidity symptoms in Parkinson patients; and allow them to complete a more effective training session.[5]

OBJECTIVE

The objective of this selective EBM review is to determine whether or not "Is aquatic therapy effective in improving motor activity in patients with Parkinson's disease?"

METHODS

Key words used to search the literature included hydrotherapy and Parkinson's disease. All articles were published in the English language and in peer-reviewed journals. The articles were discovered via PubMed and selected based on relevance to my clinical question and if they included patient oriented outcomes (POEMS). Inclusion criteria for this study necessitated that these studies were RCTs, published in English, primary articles, published on or after 2011. Exclusion criteria included systemic reviews and articles published before 2011. Summary of statistics used included mean change from baseline and P-values.

The studies utilized in this review include three randomized control trials; two single blind and one controlled, open-pilot trial. The population consists of adults with Parkinson's disease Hoehn and Yarhr Scale 1-3. The intervention used was water therapy, and the control group received traditional land therapy. The outcomes measured in all three studies were the improvement of overall motor activity based on the patient's Unified Parkinson's Disease Rating Scale (UPDRS), section III, motor aspect.

Table 1- Demographics & Characteristics of Included Studies

Study	Type	# Pts	Age (yrs)	Inclusion Criteria	Exclusion Criteria	W/D	Interventions
Carroll[6] (2017)	Single-blind randomized control trial	21	>65 years old	Diagnosis of PD Hoen and Yahr stages 1-3, stable medication status over last 3 mo., and be able to walk 10m 3x w/o assistance	Contraindications to aquatic therapy, including CVD or pulmonary conditions, previous history of deep brain stimulation, or any musculoskeletal condition that affects their ability to participate	2	Aquatic therapy- 45 minute session 2x/week for 6 weeks
Vivas[7] (2011)	Randomized control trial, controlled, open-label pilot trial	12	>55 years old	Follow medication schedule, diagnosis of PD Hoen and Yahr stages 2-3 in off-medication phase and lack of dementia	Unable to walk independently or had undergone surgical treatment for PD	1	Aquatic therapy- 45 minute session 2x/week for 4 weeks
Cruz[8] (2017)	Single-blind randomized control trial	30	> 40 years old	Diagnosis of PD Hoen and Yahr stages 1-3 in off-medication phase, >40 years old, receiving dopaminergic therapy over previous 4 weeks, score greater or equal to 24 on Mini-Mental Status Examination, w/o medical contraindications, and accept study norms	Individuals who did not comply with the indication criteria and the presence of articular and/or muscular lesions in the lower limbs affecting independent gait	0	Aquatic ai chi therapy- 45 minute sessions 2x/week for 10 weeks

OUTCOMES MEASURED

The outcomes measured in the trials were based on POEMs that assessed the efficacy of aquatic therapy and clinical improvement of motor activity in Parkinson patients. Motor activity was measured using section III, the motor aspect, of the Unified Parkinson's Disease Rating

Scale. Section III measurements included speech, facial expression, tremors at rest, action/postural tremors of hands, rigidity, finger taps, hand movements, rapid alternating movement, leg agility, arising from a chair, posture, gait, posture stability, body bradykinesia and hypokinesia.[6,7,8] The provider completes this scale by observing the patient during activity and giving the patient a certain number of points based on their performance.[9] The lower the score the better; scores range from 0 to 4 with 0 being equivalent to normal.[9]

RESULTS

Carroll et al. studied 21 adults aged 65 and older who were randomized and allocated into 2 groups, aquatic therapy and usual care group (11 intervention group, 10 in usual care group). These patients were recruited from Ireland and approved from the Irish Health Service Executive. The diagnosis of Parkinson's disease for these patients was based on the UK British Bank Criteria and confirmed by a neurologist, Hoehn and Yahr stages 1 through 3 with stable medication status over the past 3 months.[6] These participants were required to be able to walk 10 meters 3 times without assistance. Participants were excluded if they had contraindications, like cardiovascular or pulmonary conditions, to aquatic therapy, any previous history of deep brain stimulation, or any musculoskeletal conditions that affected their ability to exercise.[6]

The study conducted by Carroll et al. was a single-blind RCT; the participants were blinded to the group allocation and the randomization was carried out using opaque envelopes to conceal the allocation by a third party. For UPDRS part III, intention to treat analysis using last observation was used.[6] The intervention addressed in this study was aquatic exercise therapy including 45-minute session 2 times a week for 6 weeks in a local hydrotherapy pool that was 12 meters long and 6 meters wide with a depth varying from 0.6 to 1.30 meters; the water was set at 32 degrees Celsius.[6] The comparison group received usual care exercise on land with

medications. There was a mean change from baseline for the aquatic therapy group using the UPDRS section III at 6 weeks with a mean change from baseline being 4.5 points, while the mean change from baseline for the usual care group was 0.[6] Therefore, when comparing the two groups, there was a clinically significant change (p=0.01).[6]

Table 2. Outcome variables at T1 (baseline) and T2 (after therapy) and between-group differences[6]

	Aquatic therapy group (n=10)		Usual care group (n=8)		Intervention verse usual care group
Variable	T1	T2	T1	T2	Changes T1 to T2, *p*
UPDRS section III	17.5 (8.75-21.25)	13 (5.25-16.25)	16.5 (10.25-21.25)	16.5 (11.25-21.75)	P= 0.01*
NOTES: values are median (interquartile range) or as otherwise indicated. *Statistically significant					

Vivas et al. studied 12 adults aged 55 and older (8 men and 4 women) who were diagnosed with Parkinson's disease from the Parkinson's disease Association of Ferrol, Galicia. They were evaluated for baseline (pretest) then randomly allocated to either a land-based therapy (active control group) or a water-based therapy (experimental group). Participants were included if they were able to follow a stable medication schedule, have been diagnosed with Parkinson's stages 2 or 3 according to Hoehn and Yahr and were not diagnosed with dementia. Participants were excluded if they could not walk independently or had to undergo surgery for their disease.[7]

The study conducted by Vivas et al. was a randomized controlled, open-label pilot trial where a single physiotherapist performed the sessions with each participant individually for all sessions. The intervention addressed in this study was aquatic therapy including 45-minute sessions twice a week for 4 weeks, followed by a retest after the intervention (posttest), and a follow-up assessment after 17 days (posttest-2). Evaluations for each participant were conducted with 12-hours of withholding medication. Aquatic intervention was in a city spa with the pool measuring 3.55 meters wide, 7.75 meters long, and 1.30 meters deep with a temperature no less than 32 degrees Celsius.[7] Before starting the intervention, the groups were similar in variables

analyzed. A follow-up ANOVA was performed and showed that participants in the water-group, from pretest to posttest, changed significantly in the UPDRS scores compared to participants in the land-based group that did not change significantly. In this study a p value of 0.05 was required to establish significance. Between the groups there was a statistically significant difference in the water-group, with a p-value of 0.001 as seen in table 3.[7]

Table 3. Effects of the Therapy; pretest, posttest, posttest-2 UPDRS part III.[7]

UPDRS score	Pretest	Posttest	Posttest-2	Interaction evaluation x group (E x G	Follow-up ANOVA (if significant E x G) Factor Evaluation
Water	45.80+/-10.38	32.20+/-5.85	39.80+/-6.14	F2,18=4.012, P=0.036	F2,8= 20.315, P=0.001*
Land	36.33+/-14.71	32.67+/-11.18	34.83+/-8.18		F2,10-.965, p=.414
NOTE: values are mean +/- SD or as otherwise indicated. Table represents the effect of Factor Evaluation along the whole protocol. In case of significant interaction (ExG), which means the effect is different for both groups, a follow-up ANOVA was performed. *Statistically significant.					

Perez de la Cruz et al. studied 30 patients over the age of 40 with 15 randomly assigned to the aquatic sessions (intervention group) and 15 randomly assigned to the dry land therapy (control group). These patients were diagnosed with Parkinson's disease from two Parkinson's associations in Spain.[8] Inclusion criteria for this study included individuals diagnosed with Parkinson's disease stages 1 to 3 based on Hoen and Yahr Scale while not on medication, receiving dopaminergic therapy over the previous four weeks and who had a score of 24 or more on a Mini-Mental State Examination Scale.[8] Patients were excluded if they did not comply with the inclusion criteria and if there was the presence of articular and/or muscular lesion in the lower extremities that would alter their independent gait.[8]

The study conducted by Perez de la Cruz et al. was a single blind RCT where all patients received an initial 30 to 45 minute assessment on land for a baseline measurement. Once randomized into the two groups, the control group received 20 twice-weekly sessions over 10

weeks; each session was 45 minutes. The intervention group received 20 twice-weekly sessions during the same period as the control group; these were also 45-minute sessions. The aquatic therapy took place in a pool measuring 25x6 meters and a depth of 110 to 145 centimeters with a water temperature of 30 degrees Celsius.[8] For this study, a power calculation analyses (G-power) indicated a sample size of 15 was required for each group in order to detect a decrease in UPDRS motor score. The groups were required to detect an effect size of Cohen's d=0.56 for a reduction in UPDRS score (5 point decrease) in the aquatic group when compared to the land therapy group (power=0.8, alpha=0.05, correlation with covariate=0.05).[8] Patients from each group were analyzed at baseline, post-treatment and one-month follow-up. For motor activity using the UPDRS scale, Perez de la Cruz et al, wrote in his article that "there were significant differences in almost all sections under study, with exception of section four".[8] This does not correlate with the date found on table 4. The aquatic therapy group's mean measurement was 15.33 pre-test and remained 15.33 post-test 1 and 2. However, the treatment*time did have an effect, with a F=23.1 and a P-value < 0.001. So, that F value and P value both correlate with Cruz's narrative but the mean measurement and standard deviation data does not.[8]

Table 4. Results for the Unified Scale for the Assessment of Parkinson's disease (UPDRS).[8]

	Measure Mean (SD)			Intra-subject effects**	
Variable	Pre	Post	Post-2	Time F(d.f); P value (eta^2)	Treatment*time F(d.f); P value (eta^2)
UPDRS 3				F(1.1;29.6)=29.11; P<0.001 (0.097)	F(1.1;29.29)=23.1; P<0.001 (0.354)
Dry	15.13(7.1)	15.07(7.1)	15.07 (7.1)	NOTES: d.f.: degrees of freedom. Eta^2: partial eta squared (Effect size).	
Aquatic	**15.33(7.5)**	**15.33(7.5)**	**15.33(7.5)**		
Total	15.23(7.3)	15.20(7.3)	15.20(7.3)		

DISCUSSION

Carroll et al. and Vivas J et al. both elicited statistically significant improvements for Parkinson patients in motor activity, including things like balance, mobility, bradykinesia and the symptoms measured on the motor aspect section of the Unified Parkinson's Disease Rating

Scale. Perez de la Cruz et al. also showed a statistically significant improvement in motor activity as stated in the author's narrative. However, I believe that table 4, representing the mean and standard deviation for UPDRS 3 was incorrectly published and does not correlate with the narrative in the article. The aquatic group had identical means and standard deviations for all three measurements, but the treatment time on the right side of table 4 shows clinical significance to match the narrative. Therefore, I believe the narrative and treatment time are correct and with that, they answer my clinical question. Through my research, I was not able to find any errata published to correct this error.

A limitation in Carroll et al. was that the sample size calculation was based on an estimate of the change reported for the UPDRS score, since no other studies at that time tested for the same thing. This study also looked at a rather small sample size, which could have possibly affected the ability to detect a significant change.[6] Along with that, the patients tested in this study fell under a diagnosis of early to middle stages of Parkinson's disease excluding evidence for more advanced stages, leaving the effects for aquatic therapy on these patients unknown.[6] A limitation in Vivas J et al. was that the patients in the control group at baseline were diagnosed with Parkinson's disease much longer than the patients in the experimental group. Also, the outcomes for the UPDRS in this study combined all sections into one.[7] A limitation in Perez de la Cruz et al. was the small sample size and the short follow-up period, which in turn could have falsely magnified the results in the study.

With regards to my research, I was only able to find these three articles that specifically used UPDRS scale to measure motor ability. Other articles had to be excluded due to my decision to only use English language articles and articles published on or after 2011. Two of my three articles used the entire UPDRS scale, including section 3 but not limited to it, so the

scores took all aspects into consideration. While on the other hand, one of the articles used specifically section 3 of the UPDRS scale. Another limitation in my research that would potentially make the statistical findings not really significant after all is considering the clinical importance difference of the UPDRS scores. According to Shulman et al. a clinically important difference in the motor aspect of UPDRS is a decrease of 2.5 points for a minimal, 5.2 points for a moderate and 10.8 points for a large difference.[9]

CONCLUSSION

The intervention of aquatic therapy when compared to a land-based therapy did show statistically significant improvements in motor activity in individuals with Parkinson's disease. Aquatic therapy is an efficient, easy, enjoyable and safe intervention for patients diagnosed with varying stages of Parkinson's disease (Hoehn and Yahr Scale 1-3), and can be considered as a treatment protocol but should not be a standard of care since it has not proven to have exponentially greater outcomes than land-based therapy. Pools are easily accessible and are well affordable providing a cost-effective option for therapy. Aquatic therapy can be considered by health professionals as an adjuvant therapy to medication, physical therapy (land-based) and occupational therapy. However, studies should be carried out with greater sample sizes for longer periods to confirm these findings and ensure the longevity of the benefits. Researchers should also take into consideration if patient's medication is in an "ON" or "OFF" state. Along with that, the treatment effect needs to be compared to clinically important differences of UPDRS scores in order to tell whether the improvement of scores were really significant. Lastly, patients of all different stages of Hoehn and Yarhr should be considered not just limited to stages 1 through 3.

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